

Constants

$$c = 3.0 \times 10^8 \frac{\text{m}}{\text{s}} \quad e = 1.6 \times 10^{-19} \text{C} \quad \epsilon_0 = 8.85 \times 10^{-12} \frac{\text{C}^2}{\text{Nm}^2} \quad \mu_0 = 4\pi \times 10^{-7} \frac{\text{Tm}}{\text{A}}$$

$$m_e = 9.11 \times 10^{-31} \text{kg} \quad m_p = 1.67 \times 10^{-27} \text{kg}$$

Chapter 15

$$v = f\lambda \quad k = \frac{2\pi}{\lambda} \quad \omega = 2\pi f = \frac{2\pi}{T} \quad \frac{\partial^2 y(x,t)}{\partial x^2} = \frac{1}{v^2} \frac{\partial^2 y(x,t)}{\partial t^2}$$

$$\frac{\partial y(x,t)}{\partial t} = \mp v \frac{\partial y(x,t)}{\partial x} \quad v = \sqrt{\frac{F}{\mu}} \quad \text{Power} = F_y(x,t)v_y(x,t) \quad P_{\text{av}} = \frac{1}{2} \sqrt{\mu F} \omega^2 A^2$$

$$\frac{I_1}{I_2} = \frac{r_2^2}{r_1^2} \quad y(x,t) = A_{\text{sw}} \sin(kx) \cos(\omega t)$$

Chapter 16

$$p(x,t) = -B \frac{\partial y(x,t)}{\partial x} \quad p_{\text{max}} = BkA \quad v = \sqrt{\frac{B}{\rho}} \quad v = \sqrt{\frac{\gamma RT}{M}}$$

$$T_{\text{kelvin}} = T_C + 273.15 \quad v = \sqrt{\frac{Y}{\rho}} \quad I = \langle p(x,t)v_y(x,t) \rangle_t \quad I = \frac{1}{2} \sqrt{\rho B} \omega^2 A^2$$

$$\beta = (10\text{dB}) \log \frac{I}{I_0} \quad I_0 = 10^{-12} \frac{\text{W}}{\text{m}^2} \quad f_{\text{beat}} = f_a - f_b \quad f_L = \frac{v+u_L}{v+u_S} f_s$$

Chapter 21

$$F = k \frac{|q_1 q_2|}{r^2} = \frac{1}{4\pi\epsilon_0} \frac{|q_1 q_2|}{r^2} \quad \epsilon_0 = 8.85 \times 10^{-12} \frac{\text{C}^2}{\text{Nm}^2} \quad k = 8.988 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2} \quad \vec{E} = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} \hat{r}$$

$$p = dq \quad \vec{\tau} = \vec{p} \times \vec{E} \quad U = -\vec{p} \cdot \vec{E}$$

Chapter 22

$$\Phi_E \equiv \int \vec{E} \cdot d\vec{A} \quad \oint \vec{E} \cdot d\vec{A} = \frac{Q_{\text{encl}}}{\epsilon_0}$$

Chapter 23

$$V = \frac{1}{4\pi\epsilon_0} \frac{q}{r} \quad -\Delta V = V_a - V_b = \int_a^b \vec{E} \cdot d\vec{l} \quad \vec{E} = -\left(\hat{i} \frac{\partial V}{\partial x} + \hat{j} \frac{\partial V}{\partial y} + \hat{k} \frac{\partial V}{\partial z}\right)$$

Chapter 24

$$C = \frac{Q}{V_{ab}} \quad \frac{1}{C_{\text{series}}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots \quad C_{\text{parallel}} = C_1 + C_2 + C_3 + \dots \quad U = \frac{1}{2} CV^2 = \frac{1}{2} QV$$

$$u = \frac{1}{2} \epsilon_0 E^2 \quad C = KC_0 \quad u = \frac{1}{2} K \epsilon_0 E^2 \quad \oint K \vec{E} \cdot d\vec{A} = \frac{Q_{\text{encl-free}}}{\epsilon_0}$$

Chapter 25

$$I = \frac{dQ}{dt} = n|q|v_d A \quad \vec{J} = nq\vec{v}_d \quad \rho = \frac{E}{J} \quad \rho(T) = \rho_0 [1 + \alpha(T - T_0)]$$

$$V = IR \quad R = \frac{\rho L}{A} \quad V_{ab} = \mathcal{E} - Ir \quad P = V_{ab} I$$

$$P_{\text{resistor}} = V_{ab} I = I^2 R$$

Chapter 26

$$R_{\text{eq}} = R_1 + R_2 + R_3 + \dots \quad \frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots \quad \text{KCR} \sum I = 0 \quad \text{KVR} \sum V = 0$$

$$V_C = \frac{q}{C} \quad q_C(t) = C\mathcal{E} (1 - e^{-t/RC}) \quad i = \frac{dq}{dt}$$

Chapter 27

$$\vec{F} = q\vec{v} \times \vec{B} \quad \Phi_B = \int \vec{B} \cdot d\vec{A} \quad \oint \vec{B} \cdot d\vec{A} = 0 \quad R = \frac{mv}{|q|B} \quad \vec{F} = I\vec{l} \times \vec{B}$$

$$d\vec{F} = Id\vec{l} \times \vec{B} \quad \mu = IA \quad \vec{\tau} = \vec{\mu} \times \vec{B} \quad U = -\vec{\mu} \cdot \vec{B}$$

Chapter 28

$$\vec{B} = \frac{\mu_0 q \vec{v} \times \hat{r}}{4\pi r^2} \quad d\vec{B} = \frac{\mu_0 I d\vec{l} \times \hat{r}}{4\pi r^2} \quad B_{\text{straight wire}} = \frac{\mu_0 I}{2\pi r} \quad \frac{F}{L} = \frac{\mu_0 I I'}{2\pi r}$$

$$B_{x\text{hoop}} = \frac{\mu_0 I a^2}{2(x^2 + a^2)^{3/2}} \quad B_x = \frac{\mu_0 N I}{2a} \quad \oint \vec{B} \cdot d\vec{l} = \mu_0 I_{\text{encl}}$$

Chapter 29

$$\mathcal{E} = -\frac{d\Phi_B}{dt} \quad \mathcal{E} = vBL \quad \mathcal{E} = \oint (\vec{v} \times \vec{B}) \cdot d\vec{l}$$

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{\text{encl}}}{\epsilon_0} \quad \oint \vec{B} \cdot d\vec{A} = 0 \quad \oint \vec{B} \cdot d\vec{l} = \mu_0 (i_C + \epsilon_0 \frac{d\Phi_E}{dt})_{\text{encl}} \quad \oint \vec{E} \cdot d\vec{l} = -\frac{d\Phi_B}{dt}$$

Chapter 30

$$\mathcal{E}_2 = -M \frac{di_1}{dt} \quad \mathcal{E}_1 = -M \frac{di_2}{dt} \quad M = \frac{N_2 \Phi_{B2}}{i_1} = \frac{N_1 \Phi_{B1}}{i_2} \quad \mathcal{E} = -L \frac{di}{dt}$$

$$L = \frac{N \Phi_B}{i} \quad U = \frac{1}{2} L I^2 \quad u = \frac{B^2}{2\mu_0} \quad u = \frac{B^2}{2\mu}$$

$$V_L = L \frac{di}{dt} \quad \tau = \frac{L}{R} \quad \omega = \sqrt{\frac{1}{LC}}$$

Chapter 31

$$I_{\text{rms}} = \frac{I}{\sqrt{2}} \quad V_{\text{rms}} = \frac{V}{\sqrt{2}} \quad i = I \cos \omega t \quad v = V \cos(\omega t + \phi) \quad V_R = IR$$

$$V_L = IX_L = I\omega L \quad V_C = IX_C = \frac{I}{\omega C} \quad V = IZ \quad Z = \sqrt{R^2 + (X_L - X_C)^2} \quad \tan \phi = \frac{X_L - X_C}{R}$$

$$P_{\text{av}} = \frac{1}{2} VI \cos \phi \quad \frac{V_2}{V_1} = \frac{N_2}{N_1} \quad V_1 I_1 = V_2 I_2$$

Chapter 32

$$E = cB \quad c = \frac{1}{\sqrt{\epsilon_0 \mu_0}} \quad B = \epsilon_0 \mu_0 c E \quad \vec{E}(x, t) = \hat{j} E_{\text{max}} \cos(kx - \omega t)$$

$$\vec{B}(x, t) = \hat{k} B_{\text{max}} \cos(kx - \omega t) \quad E_{\text{max}} = c B_{\text{max}} \quad v = \frac{1}{\sqrt{\epsilon \mu}} = \frac{1}{\sqrt{K \epsilon_0 K_m \mu_0}} \quad \vec{S} = \frac{1}{\mu_0} \vec{E} \times \vec{B}$$

$$I = S_{\text{av}} = \frac{E_{\text{max}} B_{\text{max}}}{2\mu_0} = \frac{E_{\text{max}}^2}{2\mu_0 c} \quad \frac{1}{A} \frac{dp}{dt} = \frac{S}{c} = \frac{EB}{\mu_0 c}$$

Chapter 33

$$n = \frac{c}{v} \quad \lambda = \frac{\lambda_0}{n} \quad n_a \sin \theta_a = n_b \sin \theta_b \quad \sin \theta_{\text{acrit}} = \frac{n_b}{n_a} \quad I = I_{\text{max}} \cos^2 \phi \quad \tan \theta_p = \frac{n_b}{n_a}$$

Chapter 34

$$\frac{1}{s} + \frac{1}{s'} = \frac{2}{R} = \frac{1}{f} \quad m \equiv \frac{y'}{y} = -\frac{s'}{s} \quad \frac{n_a}{s} + \frac{n_b}{s'} = \frac{n_b - n_a}{R} \quad m = -\frac{n_a s'}{n_b s} \quad \frac{1}{s} + \frac{1}{s'} = \frac{1}{f} = (n - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$M = \frac{\theta'}{\theta} = \frac{25\text{cm}}{f}$$

Chapter 35

$$d \sin \theta = m \lambda \quad (m = 0, \pm 1, \pm 2, \dots) \quad d \sin \theta = \left(m + \frac{1}{2}\right) \lambda \quad (m = 0, \pm 1, \pm 2, \dots) \quad y_m = R \frac{m \lambda}{d}$$

$$2t = m \lambda \quad (m = 0, 1, 2, \dots) \quad \phi = \frac{2\pi}{\lambda} (r_2 - r_1) \quad I = I_0 \cos^2 \frac{\phi}{2}$$

Chapter 36

$$\sin \theta = \frac{m \lambda}{a} \quad (m = \pm 1, \pm 2, \dots) \quad I = I_0 \left\{ \frac{\sin[\pi a (\sin \theta) / \lambda]}{\pi a (\sin \theta) / \lambda} \right\}^2 \quad d \sin \theta = m \lambda \quad (m = 0, \pm 1, \pm 2, \pm 3, \dots)$$

$$\sin \theta_1 = 1.22 \frac{\lambda}{D}$$